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PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

BERESFORD, Keith, Denis, Lewis
Beresford & Co
2-5 Warwick Court
High Holborn
London WC1R 5DH
ROYAUME-UNI

Date of mailing (day/month/year)
18 September 2001 (18.09.01)

Applicant's or agent's file reference
AM/1829999

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/02633

International filing date (day/month/year)
10 July 2000 (10.07.00)

1. The following indications appeared on record concerning:

[X] the applicant [X] the inventor [ ] the agent [ ] the common representative

Name and Address
MORRISON, Euan
Scientific Generics Limited
Harston Mill
Harston
Cambridgeshire CB2 5GG
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [ ] the name [X] the address [ ] the nationality [ ] the residence

Name and Address
MORRISON, Euan
Quantumbeam Limited
Abbey Barns
Duxford Road
Ickleton
Cambridgeshire CB10 1SX
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[X] the International Preliminary Examining Authority
[ ] the designated Offices concerned
[X] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

Authorized officer
Dominique DELMAS
Telephone No.: (41-22) 338.83.38

Form PCT/IB/306 (March 1994)

004294683

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

BERESFORD, Keith, Denis, Lewis
Beresford & Co
2-5 Warwick Court
High Holborn
London WC1R 5DH
ROYAUME-UNI

Date of mailing (day/month/year)
21 February 2001 (21.02.01)

Applicant's or agent's file reference
AM/1829999

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/02633

International filing date (day/month/year)
10 July 2000 (10.07.00)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address
SCIENTIFIC GENERICS LIMITED
Harston Mill, Harston
Cambridgeshire CB2 5NH
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [X] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address
QUANTUMBEAM LIMITED
Harston Mill, Harston
Cambridgeshire CB2 5NH
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[X] the International Searching Authority
[ ] the International Preliminary Examining Authority
[X] the designated Offices concerned
[ ] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer
Dominique DELMAS

Telephone No.: (41-22) 338.83.38

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.TENT COOPERATION TRE. . Y

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

BERESFORD, Keith, Denis, Lewis
Beresford & Co
2-5 Warwick Court
High Holborn
London WC1R 5DH
ROYAUME-UNI

Date of mailing (day/month/year) 27 March 2001 (27.03.01)	
Applicant's or agent's file reference AM/1829999	**IMPORTANT NOTIFICATION**
International application No. PCT/GB00/02633	**International filing date** (day/month/year) 10 July 2000 (10.07.00)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address

SCIENTIFIC GENERICS LIMITED
Harston Mill, Harston
Cambridgeshire CB2 5NH
United Kingdom

State of Nationality	State of Residence
GB	GB

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[X] the person [ ] the name [ ] the address [ ] the nationality [ ] the residence

Name and Address

QUANTUMBEAM LIMITED
Harston Mill, Harston
Cambridgeshire CB2 5GG
United Kingdom

State of Nationality	State of Residence
GB	GB

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

CORRECTED VERSION

4. A copy of this notification has been sent to:

[X] the receiving Office
[X] the International Searching Authority
[ ] the International Preliminary Examining Authority
[X] the designated Offices concerned
[ ] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Dominique DELMAS

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 11 April 2001 (11.04.01)	
International application No. PCT/GB00/02633	**Applicant's or agent's file reference** AM/1829999
International filing date (day/month/year) 10 July 2000 (10.07.00)	**Priority date** (day/month/year) 08 July 1999 (08.07.99)
Applicant GREEN, Alan, Edward et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

30 January 2001 (30.01.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer R. Raissi
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

F ENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

BERESFORD, Keith, Denis, Lewis
Beresford & Co
2-5 Warwick Court
High Holborn
London WC1R 5DH
ROYAUME-UNI

Date of mailing (day/month/year)
09 March 2001 (09.03.01)

Applicant's or agent's file reference
AM/1829999

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/02633

International filing date (day/month/year)
10 July 2000 (10.07.00)

1. The following indications appeared on record concerning:

[X] the applicant [ ] the inventor [ ] the agent [ ] the common representative

Name and Address
QUANTUMBEAM LIMITED
Harston Mill, Harston
Cambridgeshire CB2 5NH
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [ ] the name [X] the address [ ] the nationality [ ] the residence

Name and Address
QUANTUMBEAM LIMITED
Harston Mill, Harston
Cambridgeshire CB2 5GG
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[X] the International Searching Authority
[ ] the International Preliminary Examining Authority
[X] the designated Offices concerned
[ ] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

Authorized officer
Dominique DELMAS
Telephone No.: (41-22) 338.83.38

003888281

PATENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

BERESFORD, Keith, Denis, Lewis
Beresford & Co
2-5 Warwick Court
High Holborn
London WC1R 5DH
ROYAUME-UNI

Date of mailing (day/month/year)
09 March 2001 (09.03.01)

Applicant's or agent's file reference
AM/1829999

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/02633

International filing date (day/month/year)
10 July 2000 (10.07.00)

1. The following indications appeared on record concerning:

[X] the applicant [X] the inventor [ ] the agent [ ] the common representative

Name and Address
GREEN, Alan, Edward
Scientific Generics Limited
Harston Mill
Harston
Cambridgeshire CB2 5NH
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

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[ ] the person [ ] the name [X] the address [ ] the nationality [ ] the residence

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GREEN, Alan, Edward
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Harston
Cambridgeshire CB2 5GG
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[X] the International Searching Authority
[ ] the International Preliminary Examining Authority
[X] the designated Offices concerned
[ ] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer
Dominique DELMAS

Telephone No.: (41-22) 338.83.38

TENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

BERESFORD, Keith, Denis, Lewis
Beresford & Co
2-5 Warwick Court
High Holborn
London WC1R 5DH
ROYAUME-UNI

Date of mailing (day/month/year)
09 March 2001 (09.03.01)

Applicant's or agent's file reference
AM/1829999

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/02633

International filing date (day/month/year)
10 July 2000 (10.07.00)

1. The following indications appeared on record concerning:

[X] the applicant [X] the inventor [ ] the agent [ ] the common representative

Name and Address
MORRISON, Euan
Scientific Generics Limited
Harston Mill
Harston
Cambridgeshire CB2 5NH
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
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Cambridgeshire CB2 5GG
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Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[X] the International Searching Authority
[ ] the International Preliminary Examining Authority
[X] the designated Offices concerned
[ ] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

Authorized officer
Dominique DELMAS
Telephone No.: (41-22) 338.83.38

14

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
1829999		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/02633	10/07/2000	08/07/1999
International Patent Classification (IPC) or national classification and IPC H04B10/26		
Applicant QUANTUMBEAM LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

I	☒	Basis of the report
II	☐	Priority
III	☒	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☒	Lack of unity of invention
V	☒	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
VI	☐	Certain documents cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
30/01/2001	08.10.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Phillips, S Telephone No. +49 89 2399 8674

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02633

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-20 as originally filed

Claims, No.:

1-46 as originally filed

Drawings, sheets:

1/7-7/7 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

   ☐ the entire international application.

   ☒ claims Nos. 43-46.

because:

   ☒ the said international application, or the said claims Nos. 43-46 relate to the following subject matter which does not require an international preliminary examination (*specify*):
   see separate sheet

   ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

   ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

   ☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

   ☐ the written form has not been furnished or does not comply with the standard.

   ☐ the computer readable form has not been furnished or does not comply with the standard.

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

   ☐ restricted the claims.

☐ paid additional fees.

☐ paid additional fees under protest.

☒ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

☐ complied with.

☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

☐ all parts.

☒ the parts relating to claims Nos. 1-42.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-42
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-42
Industrial applicability (IA)	Yes:	Claims	1-42
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Reference is made to the following documents:

D1: US 4 777 660
D2: US 5 822 099
D3: WO 98/35328
D4: US 5 347 387
D5: EP 0 580 905

Section III

In reply to the Invitation to Restrict or Pay Additional Fees, the applicant chose neither to restrict the examination nor to pay additional fees. The examination has therefore been confined to **claims 1-42**. Claims 43-46 have not been examined and should no longer be present in the application.

Section V

1. Document D1 is regarded as being the closest prior art to the subject matter of **claims 1, 38, 41 and 42** and discloses the following features:

   First ("remote", "second" or "vehicle mounted" station in D1) and second ("first" station in D1) optical signalling devices (D1 column 1 lines 29-39) according to the preamble of claim 1 of the application, plus means for controllably steering the generated optical signal towards the first signalling device (D1 Figure 1(25) and column 4 lines 40-42 together with column 10 lines 41-61).

   In the disclosure of D1, however, the error signal from the receiver used for controlling the rotatable mirror is derived from an error signal quadrant detector which quantifies the received reflected signal (column 12 lines 10-43), whereas in the present application, the error signal is derived from a measure of the received reflected signal strength.

   The skilled person, in seeking an alternative solution to that suggested in D1 would consider other suitable alternatives for controlling the steerable mirror, and would turn to document D2, which also relates to an optical communication

system, and where it is suggested to use the received signal strength to control the transmit beam direction (Figure 4 and column 6 lines 48-67). It would be obvious for the skilled person to incorporate the teaching of D2 into the system of D1 and hence to arrive at the subject matter of the present claims.

Hence, the present application does not satisfy the criterion set forth in Article 33(3) PCT because the subject matter of **claims 1, 38, 41 and 42** lacks an inventive step.

2. The following dependent claims do not contain any features which, in combination with the features of any independent claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step, the reasons being:

Claims 2,3,22,25,32,34,35,22,25,32,34,35: This subject matter is disclosed in D1.

Claims 4,5,7,8,10-12,15-21,26-28,33,36,39,40: This subject matter appears to relate to straightforward selections which the skilled person would make from a range of obvious alternatives without exercising inventive skill.

Claim 6: This subject matter is disclosed in D5 (column 2 lines 9-11).

Claim 9,23,24,29-31,37: This subject matter is disclosed in D3.

Claim 13: This subject matter is disclosed in D2.

Claim 14: This subject matter is disclosed in D4.

Section VII

1. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Section VIII

1. The various definitions given in independent **claims 1, 38, 41 and 42** are such

that the claims as a whole are not clear and concise, contrary to Article 6 PCT. The claims should include only the minimum necessary number of independent claims in any one category with dependent claims as appropriate, (Rule 6.4 PCT).

2. In the description of the present application (page 10 line 21), a document is "incorporated by reference". Since the application should be self contained (see Guidelines PCT/GL/3 II, 4.17), this phrase should not be present.

3. There is no statement of the invention in the description in conformity with the claims as required by Rule 5.1(a)(iii) PCT.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
18 January 2001 (18.01.2001)

PCT

(10) International Publication Number
WO 01/05072 A1

(51) International Patent Classification[7]: H04B 10/26, 10/10, 10/207

(21) International Application Number: PCT/GB00/02633

(22) International Filing Date: 10 July 2000 (10.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9916081.4 8 July 1999 (08.07.1999) GB
9916082.2 8 July 1999 (08.07.1999) GB

(71) Applicant *(for all designated States except US)*: **SCIENTIFIC GENERICS LIMITED** [GB/GB]; Harston Mill, Harston, Cambridgeshire CB2 5NH (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **GREEN, Alan, Edward** [GB/GB]; Scientific Generics Limited, Harston Mill, Harston, Cambridgeshire CB2 5NH (GB). **MORRISON, Euan** [GB/GB]; Scientific Generics Limited, Harston Mill, Harston, Cambridgeshire CB2 5NH (GB).

(74) Agents: **BERESFORD, Keith, Denis, Lewis** et al.: Beresford & Co, 2-5 Warwick Court, High Holborn, London WC1R 5DH (GB).

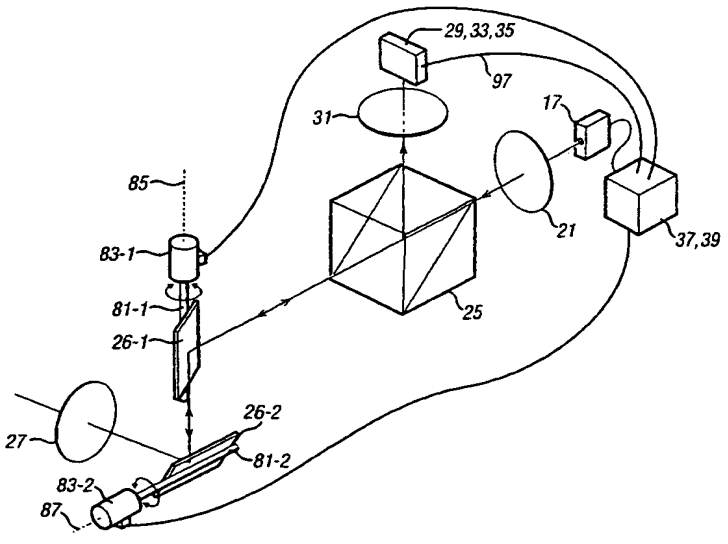
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SIGNALLING SYSTEM



(57) Abstract: An optical signalling system is provided comprising first and second signalling devices. The first signalling device comprises a retro-reflector and the second signalling device comprises a light source for transmitting light towards the retro-reflector. The second signalling device also includes means for controllably steering the optical signal towards the first signalling device; means for sensing the signal strength of the reflected signal; and means for controlling the steering means in dependence upon the sensed signal strength. The steering means may steer the beam using reflective, refractive or diffractive techniques.

WO 01/05072 A1

ENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
AM/1829999		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 02633	10/07/2000	08/07/1999
Applicant		
SCIENTIFIC GENERICS LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of Invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 5

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

Interr[illegible] Application No
PCT/GB 00/02633

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B10/26 H04B10/10 H04B10/207

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 98 35328 A (GREEN ALAN EDWARD ;PETTIGREW ROBERT MARTIN (GB); SCIENT GENERICS L) 13 August 1998 (1998-08-13) the whole document	1-3,13, 26-42,46 4-8,14, 18,20, 21,43
A	US 4 777 660 A (GOULD GORDON ET AL) 11 October 1988 (1988-10-11) abstract column 4, line 33 - line 42 column 11, line 65 -column 12, line 3 column 12, line 34 - line 41 figure 1	1-3,13, 32,33, 36, 38-42,46

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2000	06/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Ribbe, A

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02633

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 689 354 A (ORINO KANJO) 18 November 1997 (1997-11-18) column 6, line 39 - line 42 figure 2	8,21
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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

.formation on patent family members

Inter[illegible]nal Application No
PCT/GB 00/02633

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SIGNALLING SYSTEM

The present invention relates to a signalling system. The invention has particular, although not exclusive, relevance to the alignment of an optical beam used in an optical communication system.

The applicant has proposed in their earlier International application WO 98/35328 a point to multipoint data transmission system which uses a retro-reflector to receive collimated laser beams from a plurality of user terminals, to modulate the received laser beams and to reflect them back to the respective user terminals. This point to multipoint data transmission system employs pixelated reflector/modulator arrays and a telecentric optical lens system. Each pixel in the array maps to a unique angular position in the field of view of the telecentric optical lens system. Communications with each of the user terminals is then achieved using the appropriate pixel in the array which maps to the direction in which the user terminal is located within the field of view.

In conventional free-space optical communication systems, a relatively divergent laser beam is used in order to ease alignment during installation and to allow the ends of the link to move over time and still maintain the link. However, the system described in the applicants earlier International application described above has the

disadvantage that the collection aperture at the modulator end is limited (by the telecentric lens) and the light undergoes twice the atmospheric loss due the retro-reflective nature of the system. It is possible to overcome the limitation of the telecentric aperture size by transmitting a beam with significantly lower divergence (down to the diffraction limit) over the ranges considered (approximately 200m). However, the use of such a narrow beam results in the problem that the user terminals must be accurately aligned with the retro-reflector and the problem that the system is sensitive to vibration or creepage of either end of the communication link.

The present invention aims to provide an alternative technique for maintaining alignment between the laser beam transmitted by the receiving end of the system towards the retro-reflector.

Exemplary embodiments of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a video broadcast system for supplying video signals for a plurality of television channels, to a plurality of remote users;

Figure 2 is a schematic block diagram of a local distribution node and a user terminal which forms part of

the video broadcast system shown in Figure 1;

Figure 3 is a schematic diagram of a retro-reflector array and lens system employed in the local distribution node shown in Figure 2;

Figure 4 is a schematic diagram of a pixelated modulator array forming part of the retro-reflecting modulator unit shown in Figure 3;

Figure 5 is a perspective schematic view of the components in the user terminal which forms part of the system shown in Figure 3;

Figure 6 is a plot illustrating the intensity profile of the laser beam generated by the user terminal shown in Figure 5;

Figure 7 is a block diagram illustrating a control circuit which forms part of the user terminal shown in Figure 5; and

Figure 8 is a perspective schematic view of an alternative user terminal which may be used in the system shown in Figure 3.

Figure 1 schematically illustrates a video broadcast system for supplying video signals, for a plurality of television channels, to a plurality of remote users. As

shown in Figure 1, the system comprises a central distribution system 1 which transmits optical video signals to a plurality of local distribution nodes 3 via a bundle of optical fibres 5. The local distribution nodes 3 are arranged to receive the optical video signals transmitted from the central distribution system 1 and to transmit relevant parts of the video signals to respective user terminals 7 (which are spatially fixed relative to the local distribution node 3) as optical signals through free space, i.e. not as optical signals along an optical fibre path.

In this embodiment, the video data for all the available television channels is transmitted from the central distribution system 1 to each of the local distribution nodes 3, each user terminal 7 informs the appropriate local distribution node 3 which channel or channels it wishes to receive (by transmitting an appropriate request) and, in response, the local distribution node 3 transmits the appropriate video data, to the respective user terminals 7. Each local distribution node 3 does not, however, broadcast the video data to the respective user terminals 7. Instead, each local distribution node 3 is arranged (i) to receive an optical beam transmitted from each of the user terminals 7 which are in its locality, (ii) to modulate the received beams with the appropriate video data for the desired channel or channels, and (iii) to reflect the modulated beams back to the respective user terminals 7. In addition to being

able to receive optical signals from the central distribution system 1 and from the user terminal 7, each of the local distribution nodes 3 can also transmit optical data, such as status reports, back to the central distribution system 1 via the respective optical fibre bundle 5, so that the central distribution system 1 can monitor the status of the distribution network.

Figure 2 schematically illustrates in more detail the main components of one of the local distribution nodes 3 and one of the user terminals 7 of the system shown in Figure 1. As shown in Figure 2, the local distribution node 3 comprises a communications control unit 11 which (i) receives the optical signals transmitted along the optical fibre bundle 5 from the central distribution system 1; (ii) regenerates the video data from the received optical signals; (iii) receives messages 12 transmitted from the user terminals 7 and takes appropriate action in response thereto; and (iv) converts the appropriate video data into data 14 for modulating the respective light beams 15 received from the user terminals 7. In converting the video data into modulation data 14, the communications control unit 11 will encode the video data with error correction coding and coding to reduce the effects of inter-symbol-interference and other kinds of well known sources of interference such as from the sun and other light sources.

The local distribution node 3 also comprises a retro-reflector and modem unit 13, which is arranged to receive the optical beams 15 from the user terminals 7 which are within its field of view, to modulate the respective light beams with the appropriate modulation data 14 and to reflect the modulated beams back to the respective user terminals 7. In the event that an optical beam 15 received from one of the user terminals 7 carries a message 12, then the retro-reflector and modem unit 13 retrieves the message 12 and sends it to the communications control unit 11 where it is processed and the appropriate action is taken. In this embodiment, the retro-reflector and modem unit 13 has a horizontal field of view which is greater than +/- 50° and a vertical field of view of approximately +/- 5°.

Figure 2 also shows the main components of one of the user terminals 7. As shown, the user terminal 7 comprises a laser diode 17 for outputting a laser beam 19 of coherent light. In this embodiment, the user terminals 7 are designed so that they can communicate with the local distribution node 3 within a range of approximately 200 metres with a link availability of 99.9 per cent. To achieve this, the laser diode 17 is a 150 mW laser diode which outputs a laser beam having a wavelength of 850 nm. Although this is well above the operating limit which is classified as eye safe, this embodiment makes use of the fact that if the laser beam is interrupted by a person, then this will be detectable

at the receiver (since such an interruption of the beam causes an almost instantaneous drop in received signal level) and hence in this situation, the power output of the laser can be reduced to safe levels.

As shown in Figure 2, the output laser beam 19 is passed through a collimator 21 which reduces the angle of divergence of the laser beam 19. The resulting laser beam 23 is passed through a beamsplitter 25 to a pair of steerable mirrors 26 which are used to steer the laser beam. The laser beam then passes through an optical beam expander 27, which increases the diameter of the laser beam to approximately 50 mm for transmittal to the retro-reflector and modem unit 13 located in the local distribution node 3. The optical beam expander 27 is used because a large diameter laser beam has a smaller divergence than a small diameter laser beam.

Using the optical beam expander 27 has the further advantage that it provides a fairly large collecting aperture for the reflected laser beam and it concentrates the reflected laser beam into a smaller diameter beam. The smaller diameter reflected beam is then split from the path of the originally transmitted laser beam by the beamsplitter 25 and focussed onto a photo-diode 29 by a lens 31. Since the operating wavelength of the laser diode 17 is 850nm, a silicon avalanche photo-diode (APD) can be used, which is generally more sensitive than other commercially available photo detectors, because of the low noise multiplication which can be achieved with these

devices. The electrical signals output by the photo-diode 29, which will vary in dependence upon the modulation data 14, are then amplified by the amplifier 33 and filtered by the filter 35. The filtered signals are then supplied to a control unit 37 which regenerates the clock and the video data using standard data processing techniques. The retrieved video data 38 is then passed to the user unit 39, which, in this embodiment, comprises a television receiver in which the video data is displayed to the user on a CRT (not shown).

The control unit 37 is also used to control the steering of the steerable mirrors 26 so that the laser beam is optimally aligned with the local distribution node 3. The control unit 37 also monitors and keeps a history of the recent signal strength so that, if the beam is interrupted, it can pass a control signal to the laser control unit 41 so that the power of the laser diode 17 is reduced to a class 1 level (0.25mW). Provided this power reduction can be achieved within one millisecond of the beam being interrupted, this would provide a system which could be considered as class 1 eye safe. As those skilled in the art will appreciate, by monitoring the recent history of the received signal strength, the control unit 37 can distinguish between slowly varying signal levels (caused for example by deteriorating atmospheric conditions) and sudden interruptions caused by, for example, a person interrupting the beam.

In this embodiment, the user unit 39 can receive an input from the user, for example indicating the selection of a desired television channel, via a remote control unit (not shown). In response, the user unit 39 generates an appropriate message 12 for transmittal to the local distribution node 3. This message 12 is output to the laser control unit 41 which controls the laser diode 17 so as to cause the laser beam 19 output from the laser diode 17 to be modulated with the message 12. As those skilled in art will appreciate, in order that the data being transmitted in opposite directions do not interfere with each other, different modulation techniques should be employed. For example, if the amplitude of the laser beam 15 is modulated by the local distribution node 3, then the laser control unit 41 should modulate, for example, the phase of the transmitted laser beam. Alternatively, the laser control unit 41 could apply a small signal modulation to the laser beam 19 to create a low-bandwidth control channel between the user terminal 7 and the local distribution node 3. This is possible provided the detector in the local distribution node 3 can detect the small variation in the amplitude of the received laser beam. Furthermore, such a small signal amplitude modulation of the laser beam would not affect a binary "on" and "off" type modulation which could be employed by the retro-reflector and modem unit 13.

The structure and function of most of the components in the user terminal 7 are well known to those skilled in

the art and a more detailed description of them shall, therefore, be omitted. However, a more detailed description of the steerable mirrors 26 and the control unit 37 will be given later.

Figure 3 schematically illustrates the retro-reflector and modem unit 13 which forms part of the local distribution node 3 shown in Figure 2. As shown, in this embodiment, the retro-reflector and modem unit 13 comprises a wide angle telecentric lens system 51 and an array of modulators and detectors 53. The design of such a wide angle telecentric lens using fisheye lens techniques is well known to those skilled in the art. In this embodiment, the telecentric lens 51 comprises lens elements 61 and 55 and a stop member 57, having a central aperture 59. The size of the aperture 59 is a design choice and depends upon the particular requirements of the installation. The structure and function of the telecentric lens system is described in the applicants earlier International application WO 98/35328, the contents of which are incorporated herein by reference.

As illustrated in Figure 3 by the two sets of rays 67 and 69, laser beams from different sources are focussed onto different parts of the array of modulators and detectors 53. Therefore, by using an array of separate modulators and detectors, the laser beams 15 from all the user terminals 7 can be separately detected and modulated by

a respective modulator and detector pair. Figure 4 is a schematic representation of the front surface (i.e. the surface facing the lens system 51) of the modulator and detector array 53 which, in this embodiment, comprises 100 columns of modulator/detector cells and 10 rows of modulator/detector cells (not all of which are shown in the figure). Each modulator/detector cell c_{ij} comprises a modulator m_{ij} and a detector d_{ij} located adjacent the corresponding modulator. In this embodiment, the size 71 of the cells c_{ij} is between 50 and 200 μm, with the spacing (centre to centre) 72 between the cells being slightly greater than the cell size 71.

The telecentric lens 51 is designed so that the spot size of a focussed laser beam from one of the user terminals 7 corresponds with the size 71 of one of the modulator/detector cells c_{ij}, as illustrated by the shaded circle 73 shown in Figure 4, which covers the modulator/detector cell c_{22}.

In this embodiment, Quantum Confined Stark Effect (QCSE, sometimes also referred to as Self Electro-optic Effect Devices or SEEDs) modulators, developed by the American Telephone and Telegraph Company (AT&T), are used for the modulators m_{ij}. The structure and function of these QCSE modulators is described in WO 98/35328 and will not be given here. In this embodiment, each of the detectors d_{ij} comprises a photo-diode which is connected to an associated amplifier, filter and clock recovery and data

retrieval unit, which operate to detect any modulation of the corresponding laser beam and to regenerate any messages 12 which are transmitted from the corresponding user terminal 7. All the recovered messages 12 are then transmitted back to the communications control unit 11 where they are processed and appropriate actions are taken.

The way in which the laser beam is steered by the steerable mirrors 26 will now be described with reference to Figures 5 to 7. Figure 5 is a perspective schematic view of the user terminal shown in Figure 2. As shown, light from the laser diode 17 passes through a collimator lens 21 and through a beamsplitter 25 to the steerable mirrors 26-1 and 26-2. As shown, steerable mirror 26-1 is mounted for rotation on the drive shaft 81-1 of motor 83-1 and can therefore be rotated about the vertical axis 85 of the shaft 81-1. The mirror 26-1 can therefore be used to steer the laser beam horizontally. As shown in Figure 5, the laser beam reflected from the mirror 26-1 hits the mirror 26-2 which is mounted for rotation with the drive shaft 81-2 of the second motor 83-2. As shown, the drive shaft 81-2 is operable to rotate the mirror 26-2 about the horizontal axis 87. As a result, the mirror 26-2 can steer the laser beam in the vertical direction. Consequently, the combination of the two mirrors 26-1 and 26-2 can steer the laser beam in any desired direction towards the appropriate local distribution load 3. In this embodiment, the control

unit 37 controls the positions of the mirrors 26-1 and 26-2 by outputting appropriate control signals to the motors 33-1 and 33-2. In particular the control unit 37 controls the motors 83 in order to maximise the level of the signal reflected from the local distribution node 3. As those skilled in the art will appreciate, typically the laser beam generated by the laser diode 17 will be non-uniform, and in many instances will approximately have a Gaussian profile. This is illustrated in Figure 6. Therefore, there will be a number of beam positions which give the same reflected signal strength. In order that the control unit 37 can detect this and determine the correct direction in which to steer the beam for maximum strength, it uses a phase sensitive detection technique. This is achieved by applying a small amplitude oscillation to each of the two mirrors 26-1 and 26-2. The resulting small modulation in the received signal strength (due to the oscillation of the mirrors) is detected by mixing the received signal with the modulating signal applied to the motors 83-1 and 83-2 used to cause the mirrors to oscillate. This is illustrated in Figure 7.

In particular, Figure 7 shows a dither signal generator 91 which generates the modulating signals used to cause the two mirrors 26 to oscillate. In this embodiment, dither signal generator 91 generates two dither signals 93-1 and 93-2 which are passed to a motor controller 95. The motor controller 95 uses the dither signal 93-1 to

control the motor 83-1 and it uses the dither signal 93-2 to control the motor 83-2. The signal 97 output from the filter 35 (shown in Figure 2) is input to two mixers 99-1 and 99-2 where the signal is mixed with a respective one of the two dither signals 93-1 and 93-2. As those skilled in the art will appreciate, the two dither signals 93-1 and 93-2 are preferably at different frequencies which are not harmonically related, in order that there is no cross talk between the signals derived from the respective mixers 99-1 and 99-2. The outputs from the mixers 99 are then filtered by a respective low pass filter 101-1 and 101-2 to remove the high frequency components. The filtered signals are then converted into digital signals by the analogue to digital converter 103 and then passed to the microprocessor 105 for processing.

When the laser beam is accurately aligned with the retro-reflector, the system will be operating near the peak of the curve shown in Figure 6. Therefore, in this case, the small oscillations will have little effect and small amplitude signals will be received by the microprocessor 105. If, however, the laser beam is misaligned and is operating off the peak shown in Figure 6, then larger signal levels will be output from one or both of the low pass filters 101. The sign of the signal will depend upon whether the mis-alignment is to the left or to the right of the peak. Therefore, the microprocessor 105 can process the signals output by the analogue to digital

converter 103 and output an appropriate control signal to the motor controller 95 to cause the mirrors 26 to be adjusted so that the beam is optimally aligned with the retro-reflector.

Figure 7 also shows that the control unit 37 includes a clock recovery and data regeneration unit 107 which is used to regenerate the modulation data 14 sent from the local distribution node 3. As shown, this data is output to the user unit 39. Figure 7 also shows that the signal 97 is input directly to the microprocessor 105, via the analogue to digital converter 103, so that the microprocessor 105 can (i) continuously monitor the signal strength of the received beam; (ii) store, in the memory 109, the recent history of the received signal strength; and (iii) if appropriate, output a control signal to the laser control unit 41 in order to reduce the power of the transmitted laser beam.

In the above embodiment, two mirrors were mounted for rotation about orthogonal axes so that the user terminals can steer their laser beams towards the retro-reflector within the local distribution node. As those skilled in the art will appreciate, other arrangements are possible. For example, a single mirror may be used if two-axis movement is provided. Further, rather than using reflective mirrors, a similar steering operation can be achieved using refraction or diffraction techniques. An example of a diffractive technique would

be to use an acousto-optic scanner in which a surface acoustic wave is launched into a piezoelectric material, the propagation wave forming a moving diffraction grating. A laser beam incident on the piezoelectric material is then diffracted by the grating, with the angle of diffraction being related to the grating pitch, and hence to the drive frequency. The laser beam is therefore steered by variation of the drive frequency. However, this type of system is not preferred due to high cost, low efficiency and the need to provide relatively high drive frequencies (several MHz).

A second type of diffractive system is the hologon, named by analogy with the polygon reflective scanner found in laser printers. Such a system comprises a disk of transparent material (typically glass or plastic) whose surface is embossed with a computer generated hologram. The hologram is designed to deflect an incoming laser beam through an angle which depends on the position of the beam on the surface of disk. Steering of the beam is achieved by rotating the disk with respect to the incident beam. Typically, two such hologons would be required to steer the beam in two directions. Such a diffractive system has the advantages that the hologons may be mounted on stepper motors and hence only consume power during a change in beam steering; the beam deflection achieved is set in advance by design and can be chosen arbitrarily; and the hologons are cheap since they can be embossed like a CD. However, the hologon

system suffers from the disadvantage of high design and tooling costs for the hologon and low optical efficiency since some of the optical power is lost through the diffraction process.

Refractive steering of the laser beam may be achieved using two wedge prisms. Such a system is shown in Figure 8. In particular, Figure 8 shows the main components of a user terminal which employs two wedge shape prisms 109-1 and 109-2 located between the optical beam expander 27 and the beamsplitter 25. If the two prisms 109 are rotated by an equal amount but in opposite directions, the laser beam is steered in the horizontal plane. The amount of the deviation is set by the angle of rotation, the prism wedge angle and the prism refractive index. To achieve vertical deviation of the laser beam, the two prisms are rotated in the same direction, to effectively rotate the plane of deviation. Therefore, any arbitrary θ, ϕ deviation can be achieved.

The refractive solution illustrated in Figure 8 has a number of advantages. In particular, the prism parameters can be chosen so that a full rotation of the prisms gives the full range of deviation required, thereby minimising the precision required of the rotation mechanism (not shown) used to rotate the prisms. Additionally, the prisms can be readily rotated using stepper motors which only require power during a change in the beam steering. Further, since a similar optical

system has been used since approximately 1930, to implement range finders in a number of cameras, the prisms and rotation mechanisms required are readily available and low cost items.

In the first embodiment described above, a high powered laser was used and the power output of the laser was reduced in the event of the beam being interrupted. As those skilled in the art will appreciate, the ability to be able to control the power of the laser beam in this way is applicable to any retro-reflecting communication technique, since the received signal level gives a reliable indication of the link integrity and since the laser is physically located at the receiver end, its output power can be controlled by electronics at the receiver.

In the above embodiments, an array of QCSE modulators were used in the retro-reflecting end of the communications link. These QCSE modulators either absorb or reflect incident light. As those skilled in the art will appreciate, other types of reflectors and modulators can be used. For example, a plane mirror may be used as the reflector and a transmissive modulator (such as a liquid crystal) may be provided between the lens and the mirror. Alternatively still, beamsplitters may be used to temporarily separate the path of the incoming beam from the path of the reflected beam and, in this case, the modulator may be provided in the path of the

reflected beam so that only the reflected light is modulated. However, such an embodiment is not preferred since it requires additional optical components to split the forward and return paths and then to recombine the paths after modulation has been effected.

In the above embodiment, a telecentric lens was used In front of the array of retro-reflectors. Whilst the use of a telecentric lens is preferred, it is not essential. Further, if a telecentric lens is used, the back focal plane of the lens may be curved or partially curved, in which case the array of modulators should also be curved or partially curved to match the back focal plane of the telecentric lens.

In the above embodiments, a multipoint to point signalling system has been described. As those skilled in the art will appreciate, many of the advantages of the systems described above will also apply to point to point signalling systems, to point to multipoint signalling systems and to multipoint to multipoint signalling systems.

In the above embodiment, the amplitude modulation of the signal strength caused by the oscillation of the mirrors was detected by mixing the signal with the dither signals. As those skilled in the art will appreciate, other techniques may be used. For example, the microprocessor 105 may detect the variation in the signal

strength from the digital samples generated from the received signal itself. The microprocessor 105 could then cause the beam to be steered in a direction and if the variation increases then it can steer the laser beam in the opposite direction.

CLAIMS

1. An optical signalling system comprising first and second signalling devices,

the first signalling device comprising means for receiving an optical signal transmitted from said second signalling device; and means for modulating the received optical signal with modulation data for the second signalling device and for reflecting the received signal back to the second signalling device; and

the second signalling device comprising: means for generating an optical signal; means for outputting the optical signal toward said first signalling device; means for receiving the reflected optical signal from said first signalling device carrying said modulation data; and means for retrieving the modulation data from said reflected signal;

characterised in that said second signalling device further comprises:

means for controllably steering the optical signal generated by said generating means towards said first signalling device;

means for sensing the signal strength of the reflected signal; and

means for controlling said steering means in

dependence upon the sensed signal strength.

2. A system according to claim 1, wherein said steering means comprising means for reflecting said optical signal.

3. A system according to claim 2, wherein said steering means comprises one or mirrors pivotally mounted relative to said generated optical signal.

4. A system according to claim 1, wherein said steering means comprises means for diffracting said generated optical signal.

5. A system according to claim 4, wherein said diffraction means comprises a moving diffraction grating.

6. A system according to claim 4, wherein said diffraction means comprises a hologram.

7. A system according to claim 6, wherein said hologram is movable relative to the generated optical signal.

8. A system according to claim 1, wherein said steering means comprises means for refracting the generated

optical signal.

9. A system according to claim 8, wherein said refracting means comprises first and second prisms.

10. A system according to claim 9, wherein said steering means is operable to steer said generated optical signal by rotating said prisms relative to said generated optical signal.

11. A system according to claim 10, wherein said first and second prisms are rotatable about the axis of the generated optical signal and wherein said steering means is operable to rotate the two prisms in opposite directions to steer the generated optical signal in a first direction and is operable to rotate the first and second prisms in the same direction to steer the generated optical signal in a second different direction.

12. A system according to any of claims 9 to 11, wherein said first and second prisms are wedge shaped.

13. A system according to any preceding claim, wherein said sensing means is operable to monitor the signal st0ength of said reflected optical signal and wherein

said control means is operable to control said steering means in dependence upon the monitored signal levels.

14. A system according to any preceding claim, wherein said control means is operable to oscillate said steering means, wherein said sensing means is operable to sense a variation in the signal strength caused by said oscillation and wherein said control means is operable to control said steering means in dependence upon the sensed variation.

15. A system according to claim 14, wherein said sensing means comprises a phase sensitive amplitude modulation detecting means.

16. A system according to claim 15, wherein said control means is operable to oscillate said steering means in accordance with at least one dither signal and wherein said detecting means comprises means for mixing said reflected signal with the at least one dither signal.

17. A system according to any preceding claim, wherein said control means comprises a microprocessor.

18. A system according to any preceding claim, wherein

said generating means is operable to generate an optical signal at a first power level and wherein said second signalling device further comprises power control means for reducing the power output of said generating means to a second power level in dependence upon the signal level of said reflected signal sensed by said sensing means.

19. A system according to claim 18, wherein said sensing means is operable to monitor a recent history of the received signal level and wherein said power control means is operable to reduce the power output of said generating means in dependence upon said recent history.

20. A system according to claim 19, wherein said sensing means is operable to sense the level of the reflected signal at regular intervals and wherein said power control means is operable to reduce the power output of said generating means if the change in signal level between sensing intervals exceeds a predetermined threshold.

21. A system according to any preceding claim, wherein said control means comprises one on more stepper motors for controlling said steering means.

22. A system according to any preceding claim, wherein said first signalling device further comprises focussing means for focussing the received optical signal onto said reflecting means.

23. A system according to claim 22, wherein said focussing means comprises a telecentric lens and wherein said reflecting means is located substantially at the focal plane of said lens.

24. A system according to claim 23, wherein said telecentric lens is a wide angled telecentric lens.

25. A system according to any of claims 22 to 24, wherein said modulating means is transmissive and is located between said focussing means and said reflecting means.

26. A system according to any preceding claim, wherein said modulating means and said reflecting means are collocated.

27. A system according to any of claims 1 to 25, wherein said modulating means and said reflecting means are separate elements.

28. A system according to any preceding claim, wherein said first signalling device comprises a plurality of modulating and reflecting means for modulating and reflecting optical signals received from a plurality of second signalling devices.

29. A system according to claim 28, wherein said plurality of modulating and reflecting means are arranged in an array.

30. A system according to claim 29, wherein said plurality of modulating and reflecting means are arranged in a regular array.

31. A system according to claim 30, wherein said plurality of modulating and reflecting means are arranged in a two dimensional array.

32. A system according to any preceding claim, wherein said reflecting means comprises a retro-reflector.

33. A system according to any preceding claim, wherein said modulating means is operable to modulate at least one of the amplitude, phase, frequency or polarisation of the received signal.

34. A system according to any preceding claim, wherein said modulating means comprises a quantum confined stark effect device.

35. A system according to any preceding claim, wherein said second signalling device is operable to transmit a message to said first signalling device and wherein said first signalling device comprises means for retrieving the message from the received signal.

36. A system according to any preceding claim, wherein said generating means comprises a laser, a laser diode or a light emitting diode.

37. A system according to any preceding claim, wherein said second signalling device further comprises an optical beam expander for increasing the diameter of the optical signal output towards said first signalling device.

38. A second signalling device comprising: means for generating an optical signal; means for outputting the optical signal towards a first signalling device; means for receiving a reflected optical signal from said first signalling device carrying modulation data; and means for

retrieving the modulation data from said reflected signal;

characterised in that said second signalling device further comprises:

means for controllably steering the optical signal generated by said generating means towards said first signalling device;

means for sensing the signal strength of the reflected signal; and

means for controlling said steering means in dependence upon the sensed signal strength.

39. A second signalling device comprising the technical second signalling device features of any of claims 1 to 37.

40. A signalling kit comprising one or more first signalling devices and one or more second signalling devices according to claim 38 or 39.

41. An optical signalling method using first and second signalling devices, the method comprising the steps of:

at the first signalling device: receiving an optical signal transmitted from said second signalling device; modulating the received optical signal with modulation

data for the second signalling device; and reflecting the received signal back to the second signalling device; and

at the second signalling device: generating an optical signal; outputting the optical signal towards said first signalling device; receiving the reflected optical signal from said first signalling device carrying said modulation data; and retrieving the modulation data from said reflected signal;

characterised by the following steps performed at the second signalling device:

controllably steering the optical signal generated in said generating step towards said first signalling device;

sensing the signal strength of the reflected signal; and

controlling said steering step in dependence upon the sensed signal strength.

42. A retro-reflecting optical communications system comprising an optical source end and a reflecting end, characterised in that the source end comprises:

means for controllably steering a generated optical signal towards said first signalling device;

means for sensing the signal strength of a reflected signal received back from said reflecting end; and

means for controlling said steering means in dependence upon the sensed signal strength.

43. An optical signalling system comprising first and second signalling devices,

the first signalling device comprising means for receiving an optical signal transmitted from said second signalling device; and means for modulating the received optical signal with modulation data for the second signalling device and for reflecting the received signal back to the second signalling device; and

the second signalling device comprising: means for generating an optical signal at a first power level; means for outputting the optical signal towards said first signalling device; means for receiving the reflected optical signal from said first signalling device carrying said modulation data; and means for retrieving the modulation data from said reflected signal;

characterised in that said second signalling device further comprises:

means for sensing the signal strength of the reflected signal; and

power control means for reducing the power output of said generating means to a second lower power level in

dependence upon the sensed signal strength.

44. A system according to claim 43, wherein said sensing means is operable to monitor a recent history of the received signal level and wherein said power control means is operable to reduce the power output of said generating means in dependence upon said recent history.

45. A system according to claim 44, wherein said sensing means is operable to sense the level of the reflected signal at regular intervals and wherein said power control means is operable to reduce the power output of said generating means if the change in signal level between sensing intervals exceeds a predetermined threshold.

46. A data distribution system comprising one or more signalling systems according to any of claims 1 to 37 or 43 to 45.

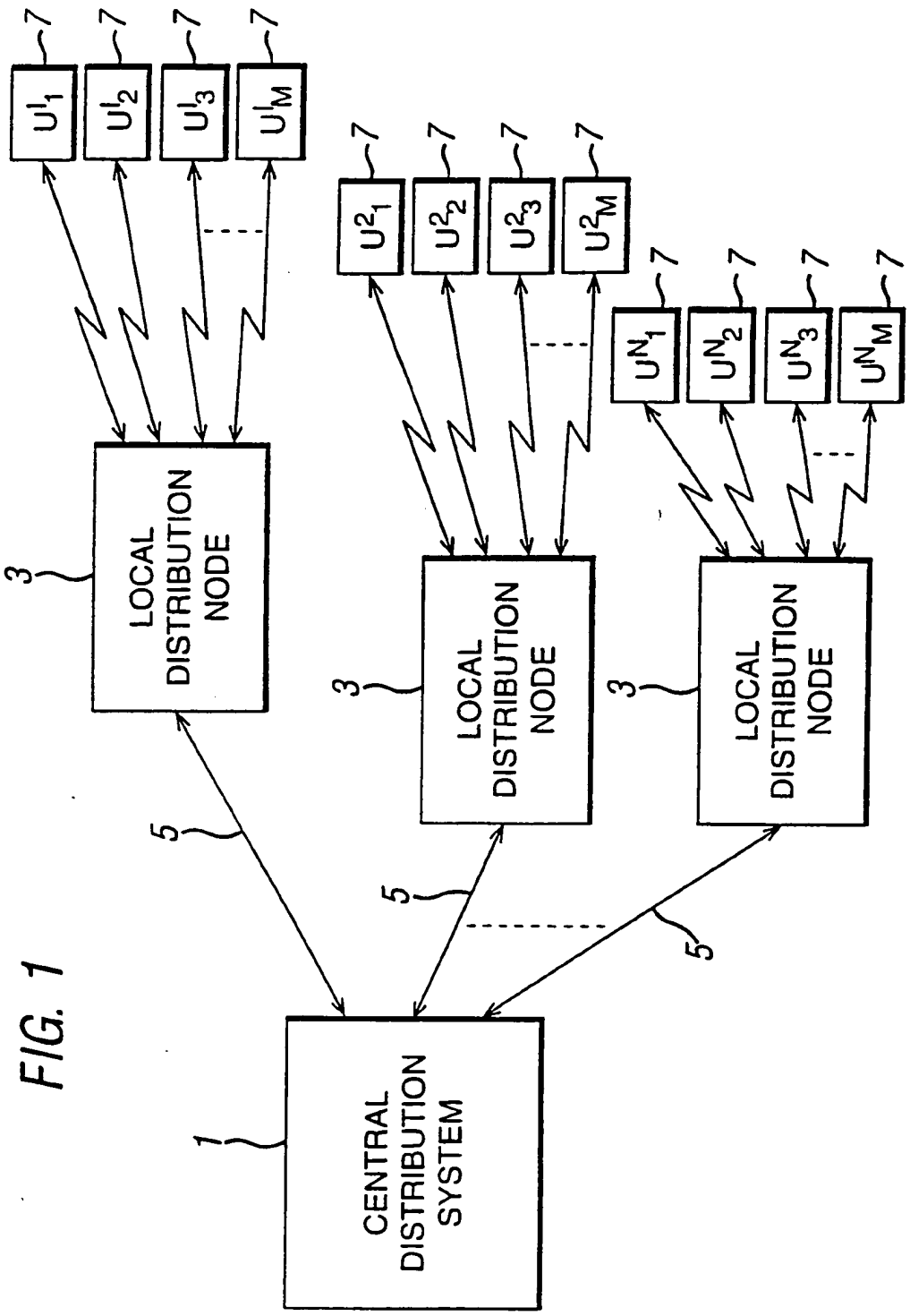

CENTRAL DISTRIBUTION SYSTEM
1
LOCAL DISTRIBUTION NODE
3
5
7
U^1_1
U^1_2
U^1_3
U^1_M
U^2_1
U^2_2
U^2_3
U^2_M
U^N_1
U^N_2
U^N_3
U^N_M

FIG. 1

FIG. 2

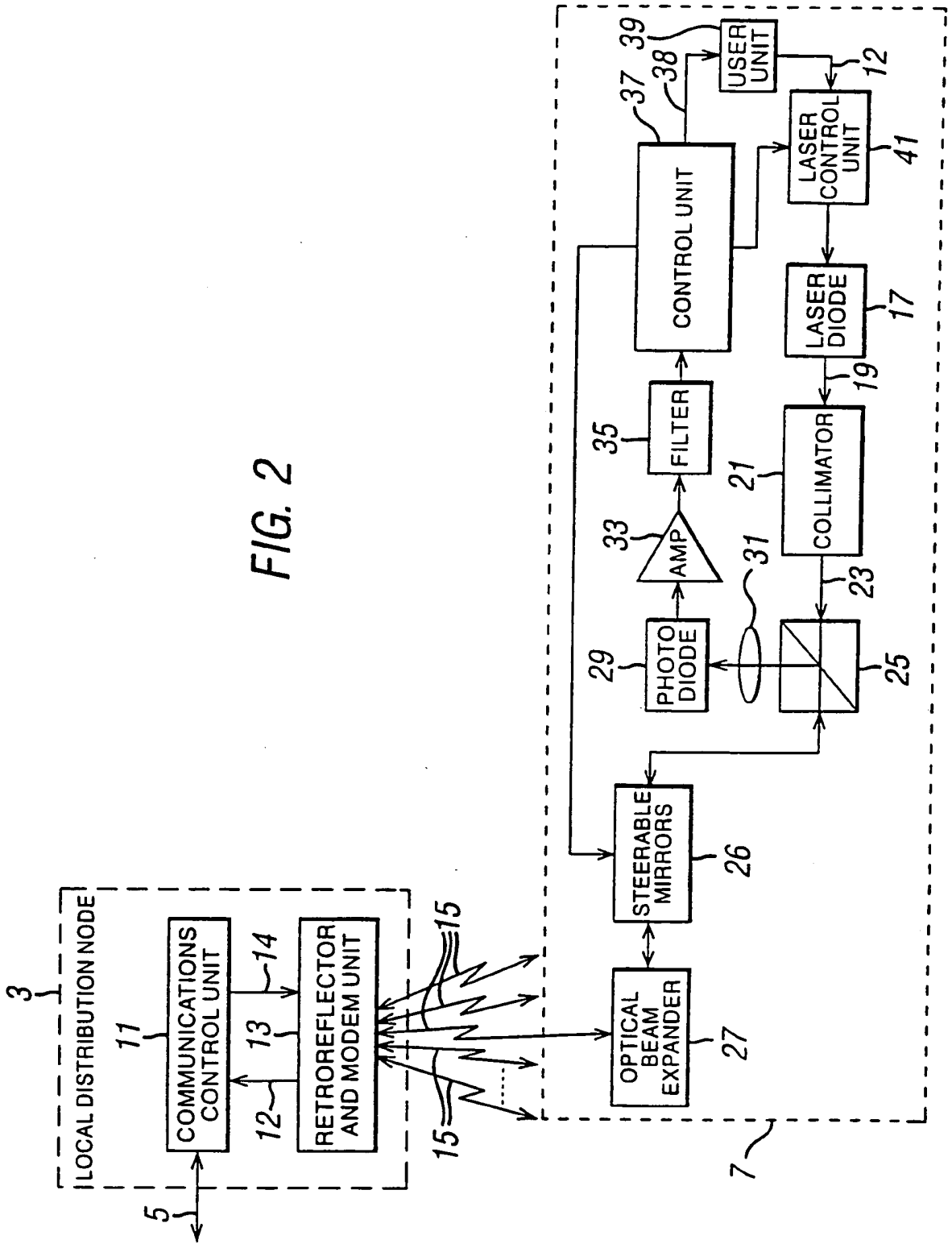

LOCAL DISTRIBUTION NODE
3
COMMUNICATIONS CONTROL UNIT
11
RETROREFLECTOR AND MODEM UNIT
13
14
12
15
15
5
7
STEERABLE MIRRORS
26
OPTICAL BEAM EXPANDER
27
PHOTO DIODE
29
AMP
33
31
FILTER
35
CONTROL UNIT
37
38
39
USER UNIT
12
LASER CONTROL UNIT
41
LASER DIODE
17
19
COLLIMATOR
21
23
25

FIG. 3

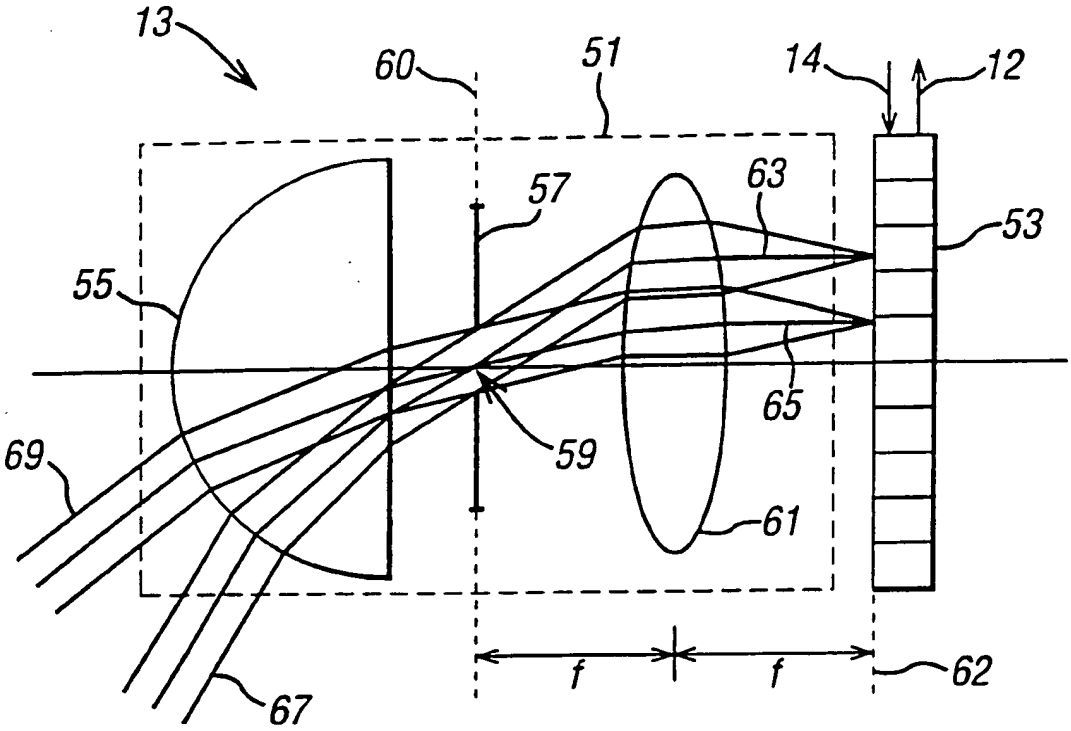
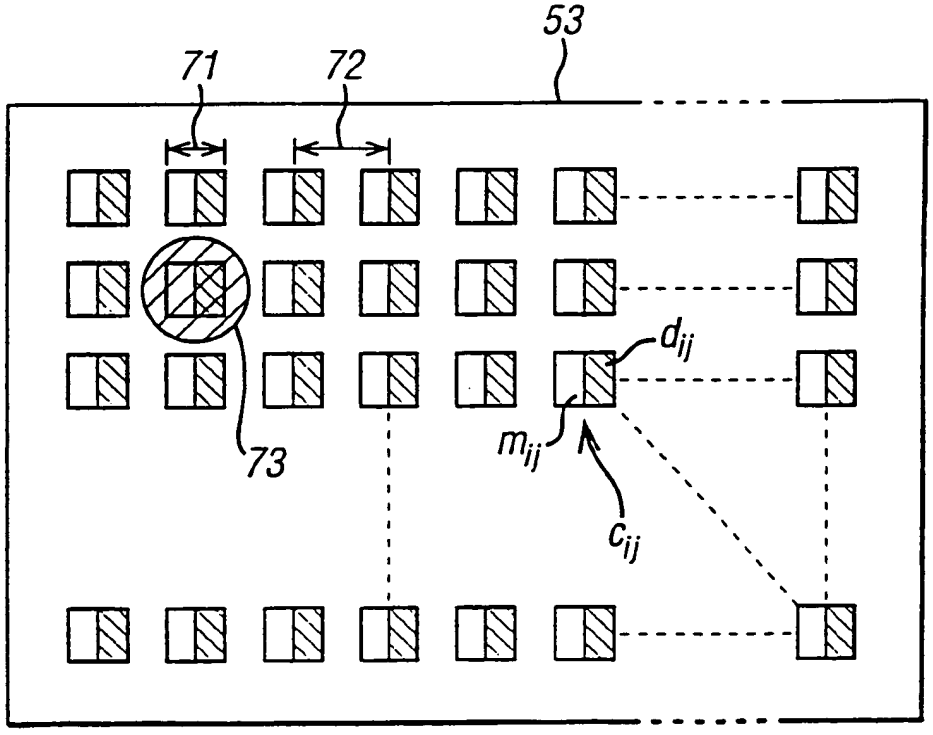


FIG. 4



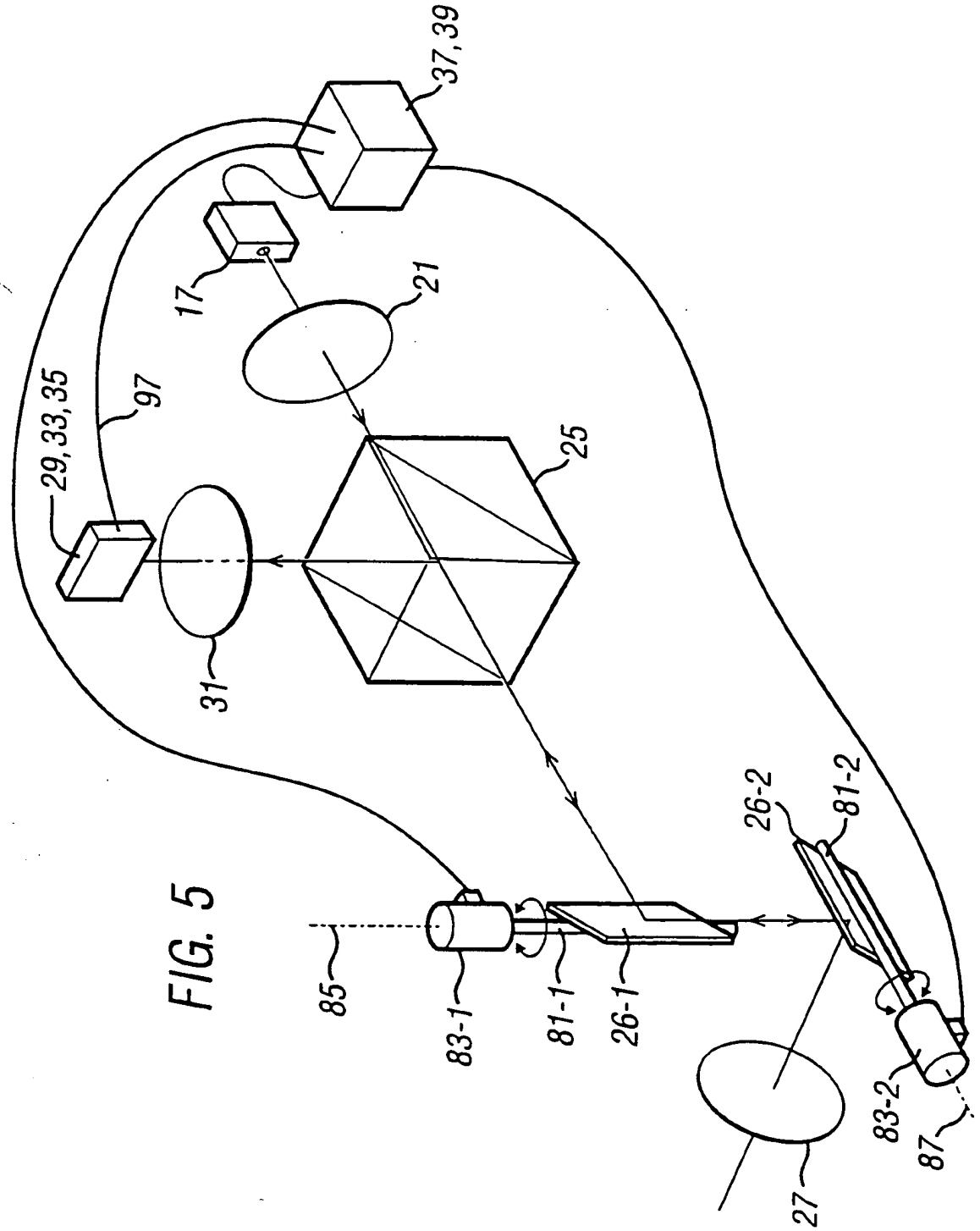


FIG. 5

FIG. 6

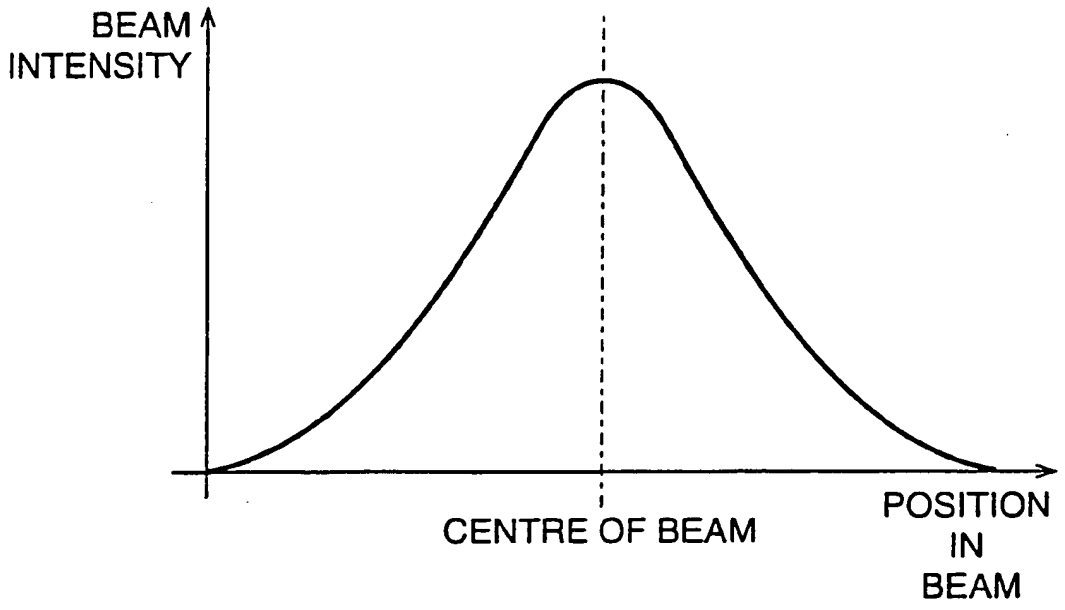
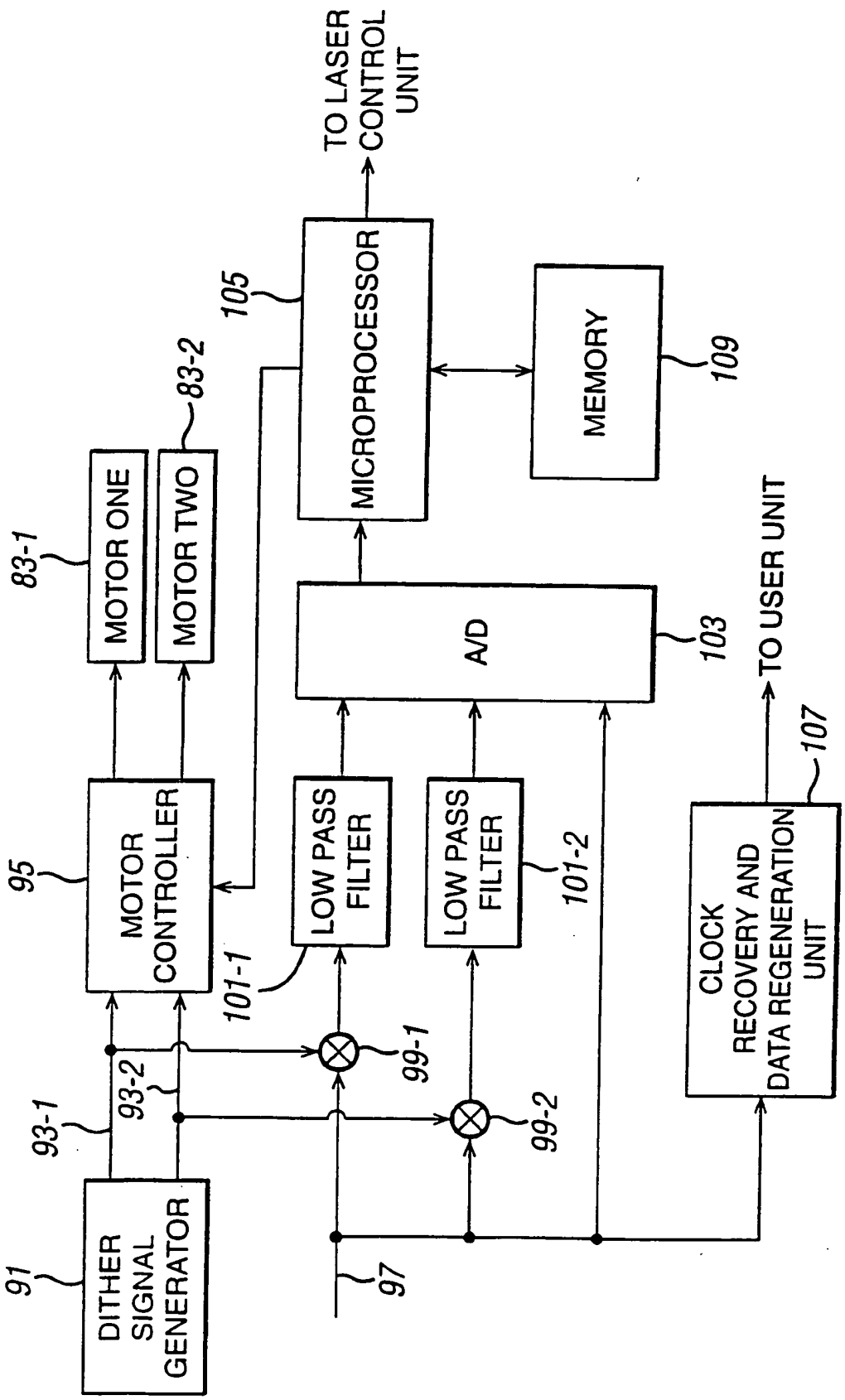


FIG. 7


TO LASER CONTROL UNIT
105
MICROPROCESSOR
MEMORY
109
83-2
83-1
MOTOR ONE
MOTOR TWO
A/D
103
TO USER UNIT
107
95
MOTOR CONTROLLER
LOW PASS FILTER
101-1
LOW PASS FILTER
101-2
CLOCK RECOVERY AND DATA REGENERATION UNIT
99-1
99-2
93-2
93-1
91
DITHER SIGNAL GENERATOR
97

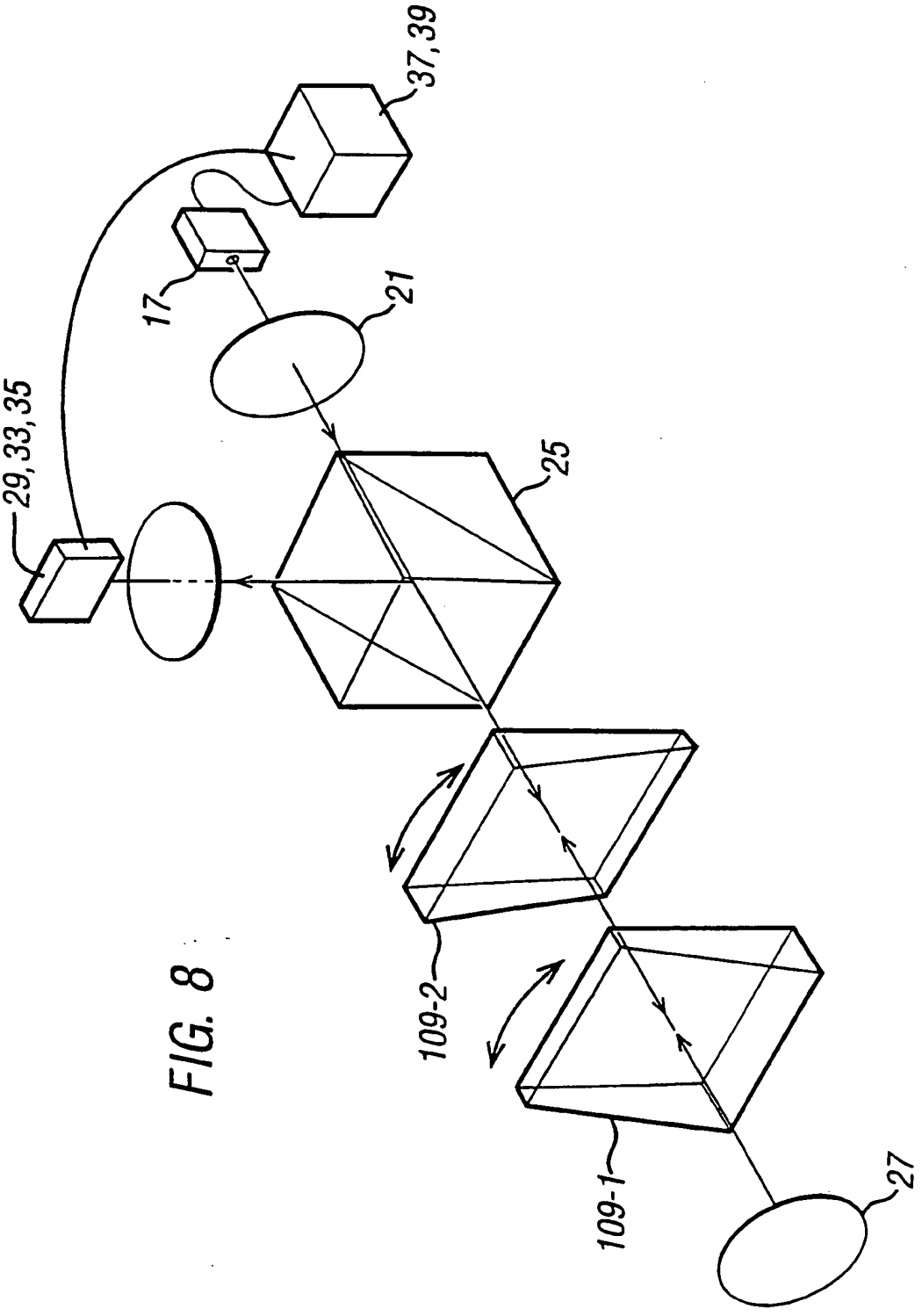


FIG. 8